DOCUMENT RESUME

ED 113 698 95 CS 002 202

AUTHOR Ghatala, Elizabeth S.; And Others
TITLE Rehearsal Strategy Effects in Children's Discrimination Learning: Confronting the Crucible. Technical Report No. 335.
INSTITUTION Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
REPORT NO WRDCCL-TR-335
PUB DATE 75
CONTRACT NE-C-00-3-0065
NOTE 22p.

EDRS PRICE MF-$0.76 HC-$1.58 Plus Postage
DESCRIPTORS *Child Language; *Cognitive Processes; *Discrimination Learning; Educational Research; Intermediate Grades; Language Development; Language Usage; *Verbal Development; *Verbal Learning
IDENTIFIERS *Rehearsal Strategy

ABSTRACT

This study incorporated a correlational methodology into an experimental context to determine the functional components of rehearsal strategies in children's discrimination learning. The subjects for this study were 120 fifth- and sixth-grade children attending two elementary schools located in middle-class areas of Ogden, Utah. According to the frequency theory, successful performance on a visual discrimination task is attributed to subjective frequency discriminations learned prior to or during the task. It was hypothesized in this study that when a rehearsal strategy is added to the verbal discrimination task, attributes other than frequency may be called into play. The results of the present experiment now make it clear that when a rehearsal strategy (of the kind employed here) is applied to a verbal discrimination list, the task appears no longer to involve frequency discriminations, as it does when a rehearsal strategy is not applied. (RB)

ED113698

Technical Report No. 335

REHEARSAL STRATEGY EFFECTS IN CHILDREN'S DISCRIMINATION LEARNING: CONFRONTING THE CRUCIBLE

by

Elizabeth S. Ghatala, Joel R. Levin,
and Michael J. Subkoviak

Report from the Project on
Children's Learning and Development

Joel R. Levin
Principal Investigator

Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin
Madison, Wisconsin

June 1975

002 202

The purchase of certain equipment utilized in the experiment was made possible by funds from the Spencer Fellowship Program of the National Academy of Education.

Published by the Wisconsin Research and Development Center for Cognitive Learning, supported in part as a research and development center by funds from the National Institute of Education, Department of Health, Education, and Welfare. The opinions expressed herein do not necessarily reflect the position or policy of the National Institute of Education and no official endorsement by that agency should be inferred.

Center Contract No. NE-C-00-3-0065

WISCONSIN RESEARCH AND DEVELOPMENT
CENTER FOR COGNITIVE LEARNING

MISSION

The mission of the Wisconsin Research and Development Center for Cognitive Learning is to help learners develop as rapidly and effectively as possible their potential as human beings and as contributing members of society. The R&D Center is striving to fulfill this goal by

- conducting research to discover more about how children learn
- developing improved instructional strategies, processes and materials for school administrators, teachers, and children, and
- offering assistance to educators and citizens which will help transfer the outcomes of research and development into practice

PROGRAM

The activities of the Wisconsin R&D Center are organized around one unifying theme, Individually Guided Education.

FUNDING

The Wisconsin R&D Center is supported with funds from the National Institute of Education; the Bureau of Education for the Handicapped, U.S. Office of Education; and the University of Wisconsin.

ACKNOWLEDGMENTS

We are grateful to the teachers and students at Taylor, Gramercy, and Hillcrest Elementary Schools in Ogden, Utah, for their cooperation. The first two authors contributed equally to this study.

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

This study incorporated a correlational methodology into an experimental context to determine the functional components of rehearsal strategies in children's discrimination learning. As anticipated on the basis of previous research, when a discrimination list was administered in the absence of explicit rehearsal instructions, the subjects' ability to discriminate situational frequencies proved to be an important predictor of performance. However, when the same list was administered in the company of either an imagery or vocalization rehearsal strategy, frequency discrimination ability as a predictor was supplanted by the subjects' ability to discriminate between previous usages and nonusages of the strategy. The results are discussed in terms of Underwood's individual differences crucible for theory construction.

I

INTRODUCTION

According to the theory developed to account for learning in a verbal discrimination task (Ekstrand, Wallace, & Underwood, 1966), successful performance is attributed to subjective frequency discriminations between correct and incorrect pair members. Ekstrand et al. have further assumed that a frequency differential arises primarily from subjects' implicit rehearsal of the correct response during the feedback phase of the task. At the same time, a number of recent investigations have clearly demonstrated that by instructing subjects to employ explicit rehearsal strategies, performance on the task improves (see Paivio, 1971). For example, in our own research with children, we have found that subjects instructed to pronounce the correct item or to image the correct item in each pair perform significantly better than subjects left to their own devices (Levin, Ghatala, DeRose, Wilder, & Norton, 1975; Levin, Ghatala, Wilder, & Inzer, 1973).

The major purpose of this study was to determine whether the frequency theory as just referred to can adequately account for such rehearsal strategy effects. Indeed, although in its current formulation the theory does not address itself directly to the effects of rehearsal strategies, its sufficiency in accounting for performance differences in the verbal discrimination task implies that frequency is the primary attribute (Underwood, 1969) through which such strategies operate. Despite this implication, however, initial tests of it have not been encouraging (see Ghatala, Levin, & Wilder, 1973). In this study, we reassess this issue using an alternative approach to theory testing.

Before we get too far, it should be mentioned that the experiment reported here was conceptualized some time before we had the benefit of Underwood's (1975) pioneer paper concerning individual differences as a "crucible" in theory construction. But, as will be seen, our approach to the problem of determining the mechanism(s) underlying strategy effects in verbal discrimination learning serves as a testimony to the logic and utility of Underwood's individual differences ingredient in nomothetic theory building.

Our working hypothesis was that when a rehearsal strategy is added to the verbal discrimination task, attributes other than frequency may be called into play. With regard to the strategies under consideration here, it may be postulated that imagery facilitates performance simply because subjects are able to remember which item in a pair they have imaged--a process somewhat comparable to Underwood's (1969) modality attribute which will be referred to here as an activity attribute.[1]

[1]At this point we can only speculate on the functional memorial component of this proposed attribute. It may consist of the processing activity per se induced by a strategy (e.g., imaging), or the product of such activity (e.g., specific images), or both.

Thus, the previous imagery activity of the subject (involving one item in each pair) provides a discriminative cue for choosing the correct item (see Rowe & Paivio, 1971). Analogously, pronunciation activity may provide articulatory and/or acoustic cues unique to the correct item within a pair and the subjects' discriminations may then be based on these cues.

According to this hypothesis, rather than serving to supply exclusive frequency information, rehearsal strategies may result in the encoding of information concerning the activity during study (and in the utilization of that information during test) which supplants frequency cues. A less extreme version of the hypothesis would be that these alternative discriminative cues work to supplement the frequency cues which obtain in the usual (i.e., without rehearsal instructions) verbal discrimination task. Some support for the notion that imagery and vocalization provide additional (or alternative) cues for discrimination was provided by Levin, Ghatala, Wilder, and Inzer (1973).

In summary, the question of how rehearsal strategies, such as imagery and vocalization, facilitate verbal discrimination learning is currently unresolved. They may do so: (1) because they enhance subjective frequency discriminations (here, the supply explanation); (2) because they produce additional discriminative cues, independent of frequency, which are used to bolster decisions based primarily on the frequency attribute (the supplement explanation); or (3) because they produce discriminative cues which are more effective than frequency cues, and thus replace them as a basis for discrimination (the supplant explanation). In the present experiment we begin to assemble the evidence necessary to facilitate choosing among these alternative explanations.

Our experiment consisted of the administration of three tasks (or variations thereof) to each subject. Task 1 was a relative frequency judgment task, designed to measure how well subjects could make frequency discriminations among verbal items. Task 2 was a verbal discrimination task; and Task 3 was what Zechmeister and Gude (1974) have called a strategy identification task, designed to measure how well subjects could discriminate between verbal items for which they had previously employed a rehearsal strategy and those for which they had not.

Four independent groups of subjects were included; subjects in all groups received the same relative frequency judgment task (Task 1). Procedural differences in the remaining two tasks defined the four experimental conditions. In the Pronunciation-Control condition, the strategy identification task (Task 3) consisted of subjects discriminating between items they had previously pronounced and those they had not. The verbal discrimination task (Task 2) was administered to these control subjects in the absence of any explicit rehearsal strategy. Subjects in the Pronunciation-Strategy condition received the same strategy identification task as the Pronunciation-Control subjects. But in addition, during the verbal discrimination task these subjects were instructed to pronounce aloud the correct item in each pair. Imagery-Control and Imagery-Strategy conditions paralleled each of the pronunciation conditions, in that subjects in both imagery conditions discriminated items they had previously imaged from those they had not in the strategy identification task, and strategy subjects (but not control subjects) were instructed to image the correct response during verbal discrimination learning.

Given certain assumptions, the three alternative explanations under consideration predict different intercorrelational patterns among the three tasks for the control and strategy conditions. The assumptions and predictions are as follows:

First, there is rather direct evidence that frequency is the predominant attribute called upon in the usual (here, control) verbal discrimination situation (see, for example, Underwood & Freund, 1970). Accordingly, in the two control conditions, subjects' ability to make frequency discriminations (as measured by the relative frequency judgment task) should be substantially related to their performance on the verbal discrimination task.

Second, given the previous assumption that frequency is the predominant attribute in verbal discrimination learning under normal circumstances plus the additional assumption that the strategy identification task measures something other than frequency discrimination ability, there should be little relationship between performance on the strategy identification task and verbal discrimination learning. Moreover, even if the strategy identification task does possess a frequency discrimination component, the relationship between this task and verbal discrimination learning should be minimal when this component is controlled for statistically.

In the two conditions where subjects employ the rehearsal strategies during discrimination learning, the relationships among the three tasks may differ in various ways (specifiable on the basis of the three alternative explanations) from those in the control groups. Thus, if imagery and vocalization produce discriminative cues which are independent of frequency, then some relationship between strategy identification performance and verbal discrimination learning would be expected (even when frequency discrimination ability is controlled for statistically). According to the supplement explanation, the relationship between performance on the relative frequency judgment task and discrimination learning should remain high (as it is in the control conditions); whereas according to the supplant explanation, this relationship should diminish or disappear. If, on the other hand, strategies operate solely via the frequency attribute (the supply explanation), then the task intercorrelational patterns should be comparable in control and strategy conditions.

II

METHOD

SUBJECTS

The subjects were 120 fifth- and sixth-grade children attending two elementary schools located in middle-class areas of Ogden, Utah. A block randomization procedure was used to assign children to conditions in order of their appearance at the testing room located within the school building. Thus, 30 children (15 fifth graders and 15 sixth graders) participated in each of the four conditions--Pronunciation-Control, Pronunciation-Strategy, Imagery-Control, Imagery-Strategy.

MATERIALS AND TASKS

From an initial pool of 208 concrete nouns, 80 words were randomly selected for use in the relative frequency judgment task, 48 for the verbal discrimination task, and 80 for the strategy identification task. In all tasks list lengths were determined on the basis of previous research, as well as pilot efforts designed to produce comparable performance variation from one condition to the next--a desired situation given the correlational nature of the experiment.

The three sets of materials were comparable on Thorndike-Lorge (1944) frequency; the average number of occurrences per million were 47.30, 46.33, and 47.50 for the relative frequency judgment, verbal discrimination, and strategy identification tasks, respectively. All of the words were in the reading vocabularies of the subjects as determined from pilot testing of the tasks.

Relative Frequency Judgment Task

In this task, items presented a differing number of times during study were paired on the test trial and subjects were required to choose the more frequent member of each pair. On the test trial there were ten 1 vs. 2 pairs (i.e., subjects were required to discriminate between items presented once and items presented twice during study). There were also ten 1 vs. 3 pairs, ten 2 vs. 3 pairs, and ten 2 vs. 4 pairs on the test. Achieving the necessary induced frequencies required 180 study presentations: 20 words were presented once; 30, twice; 20, three times; and 10, four times. All words were randomly assigned to the four presentation frequencies.

The ordering of the words across the 180 study positions was random, subject to the restriction that those with multiple occurrences appeared equally often in each equal-sized section of the list, with the number of sections being determined by the frequency (e.g., an item presented twice occurred once in each half of the list; an item presented three times occurred once in each third, and so on). The same word never occurred twice a row in adjacent positions. The words were typed on 5 x 8 inch plain white cards which were fastened into a ringed binder.

The four types of test pairs were constructed by randomly pairing items from the four frequency categories. The order of the pairs on the test was random, except that across the 40 positions each type of pair had to occur before a pair type could be repeated. The words in each test pair were typed side by side, on a 5 x 8 inch card, and the cards were then fastened into a ringed binder. The more frequent words appeared equally often in the left and right positions across the pairs.

Verbal Discrimination Task

The 48 words were randomly paired to form a 24-pair verbal discrimination list with the "correct" member of each pair being determined by the flip of a coin. The word pairs were typed on 5 x 8 inch cards which were then placed into a Rolodex card file. The task consisted of one anticipation-study (i.e., no guess) trial followed by one anticipation-test trial. On the feedback portion of each trial, the correct item in each pair was designated by a plus sign placed underneath it. A different random order of the list was used on the study and test trials. The spatial position of correct and incorrect items within pairs was arranged such that: (a) on each presentation of the list, correct and incorrect items occurred equally often in the left and right positions; and (b) for half of the pairs the position of the correct item changed from the study to the test trial.

Strategy Identification Task

Of the 80 words presented for study, 40 were randomly selected as strategy items. The subjects were instructed to apply the appropriate rehearsal strategy only to these items. That is, subjects in the pronunciation conditions pronounced these items aloud; subjects in the imagery conditions tried to image their referents. For half the subjects the strategy items were underlined during the study trial; for the other subjects the nonstrategy items were underlined and they rehearsed the nonunderlined items. This procedure was followed in order to rule out the possibility that the underlining itself furnished a usable discriminative cue. On the test trial, none of the words was underlined, and subjects were required to indicate for each word whether or not they had applied the rehearsal strategy. Two different random orders of the words were utilized on the study and test trials.

PROCEDURE

All subjects received the relative frequency judgment task first, followed seven days later by the verbal discrimination task, and finally, after another seven-day interval, the strategy identification task. All three tasks were individually administered to each subject. At the beginning of the first session, the subjects were informed that they would participate on three different occasions and that the tasks would be unrelated. At each subsequent session, the subjects were told that the words and task were different from those in the prior session. The particular order of tasks, the instructions, and the seven-day intervals were employed to minimize reactivity among the tasks. Note also that the "criterion" task, i.e., verbal discrimination learning, was sandwiched in between the two "predictor" tasks, i.e., relative frequency judgments and strategy identification, assuring that each predictor was temporally equidistant from the criterion.

The procedure for the relative frequency judgment task was identical in the four conditions. The subjects were informed that they would see a long series of words, that some of the words would occur only once while others would occur several times, and that they should pay close attention to the words because later they would be asked questions about them. The words were presented for study at a 3-second rate. The pairs were presented on the test trial at a 3-second rate with subjects pointing to the more frequent word in each pair, guessing if uncertain.

The procedure for the verbal discrimination task varied as a function of condition. Subjects in the two control conditions (Pronunciation-Control and Imagery-Control) received the usual verbal discrimination instructions; that is, they were told that on the study trial they would see a pair of words and they would then see the same pair of words again immediately with the correct word designated by a mark. Their task was to try to remember the correct word for each pair. In addition to these instructions, subjects in the Pronunciation-Strategy group were instructed to pronounce the correct item three times during the feedback portion of the study trial. Subjects in the Imagery-Strategy condition were instructed to form a picture in their minds of the referent of the correct word in each pair on the study trial. The three pronunciations versus one image difference was consistent with previous procedures (e.g., Levin, Ghatala, Wilder, & Inzer, 1973) and served to equate rehearsal times in the two conditions. On the test trial, all subjects were required to point to the correct member of each pair (guessing if uncertain) during the anticipation phase. Subjects were not instructed to pronounce or image during the test trial. A 5:5-second rate was utilized on both study and test trials in all conditions.

In the strategy identification task, subjects in the Pronunciation-Control and Pronunciation-Strategy conditions were required to pronounce each of the 40 designated strategy items three times. In the Imagery-Control and Imagery-Strategy conditions, the subjects were told to try to get ~~a mental~~ picture of the designated strategy items. No further instructions concerning the nature of the task were given to the subjects. The words were presented at a 4-second rate. On the test, the same 80 words were presented with no words underlined. The subject was to say yes if he thought he had applied the rehearsal strategy to a particular word and no, if he thought he had not applied it. Subjects were instructed to guess if uncertain. The test proceeded at a 3-second rate.

For the relative frequency judgment task and the strategy identification task, the experimenter presented the materials by turning cards fastened into loose-leaf notebooks. For the verbal discrimination task, the experimenter flipped cards mounted in a Rolodex file. Thus, the above rates of presentation are approximate. However, the experimenter was well practiced and a stopwatch was used to check rates periodically during the course of the experiment.

III

RESULTS

EXAMINATION OF MEAN PERFORMANCE

Before proceeding to the major correlational results of the experiment, it was deemed advisable to examine each of the four conditions for undesired effects on the relative frequency judgment task (due to chance attainment of groups unequal in ability) and on the strategy identification task (due to strategy practice, i.e., carry-over effects from the verbal discrimination task). In addition, we wished to check for expected effects on the verbal discrimination task (due to the application of a rehearsal strategy).

None of the possible undesired effects was obtained. That is, mean performance on the initial relative frequency judgment task was comparable across conditions ($F < 1$, with the means being virtually identical--29.5 to 29.7 correct out of 40--and the standard deviations ranging from 2.9 to 3.6). Similarly, mean performance on the strategy identification task was comparable for subjects who had previously been exposed to the strategy on the verbal discrimination task and those who had not (Pronunciation: $\bar{X}$ = 64.1 correct out of 80, S.D. = 7.4 and $\bar{X}$ = 65.2, S.D. = 6.1 in the strategy and control conditions, respectively, $|t| < 1$; Imagery: $\bar{X}$ = 59.2, S.D. = 10.3 and $\bar{X}$ = 58.8, S.D. = 8.7 in the strategy and control conditions, respectively, $|t| < 1$).

On the other hand, the rehearsal strategies were obviously effective in the verbal discrimination task (Pronunciation: $\bar{X}$ = 20.5 correct out of 24, S.D. = 2.6 and $\bar{X}$ = 17.0, S.D. = 3.2 in the strategy and control conditions, respectively, t (58) = 4.57, $p < .001$; Imagery: $\bar{X}$ = 19.0, S.D. = 2.9 and $\bar{X}$ = 16.3, S.D. = 3.2 in the strategy and control conditions, respectively, t (58) = 3.47, $p < .001$).

COMPARISON OF CORRELATIONAL PATTERNS

The intercorrelations among the three tasks for each of the four conditions are presented in Table 1. Focusing on the bottom line (VDL) in each section, one will note that in both control conditions (pronunciation and imagery), performance on the relative frequency judgment task is significantly related to verbal discrimination learning, consistent with previous research (e.g., Underwood & Freund, 1970). In contrast to this, however, is the total lack of relationship between relative frequency judgment and verbal discrimination learning in the two strategy conditions. On the other hand, in both strategy conditions the strategy identification task is highly correlated with verbal discrimination learning, whereas it is not in the two control conditions.

TABLE 1

CORRELATIONS BETWEEN TASKS FOR EACH OF THE FOUR CONDITIONS

Pronunciation

	Control RFJ	Control SI	Strategy RFJ	Strategy SI
SI	-.05	--	-.15	--
VDL	.40*	.16	.04	.64**

Imagery

	Control RFJ	Control SI	Strategy RFJ	Strategy SI
SI	-.00	--	.10	--
VDL	.40*	.15	-.08	.64**

*$p < .025$ **$p < .001$

Note: RFJ = relative frequency judgment task; SI = strategy identification task; VDL = verbal discrimination learning.

Clearly, then, it is the relative frequency judgment task which relates to verbal discrimination learning when no experimenter-induced strategy is employed, while it is the strategy identification task which relates to verbal discrimination learning when a strategy is employed, with no evidence of the other task's contribution in either case. Moreover, since the relative frequency judgment and strategy identification tasks are completely unrelated in all four conditions (see the top line [SI] in each section of Table 1), partialling out the effect of each when considering the other's relationship to verbal discrimination learning has little effect.

Despite these straightforward results, one may wonder why the significant relationships are not stronger. One possibility is that other abilities, not reflected by either relative frequency judgment performance or by strategy identification performance, are related to verbal discrimination learning (general intelligence and/or scholastic achievement, for example). However, when such measures were included in multiple regression analyses (along with the two predictor tasks), no significant increases in predictability were obtained. That is, virtually all of the "explained" variation in verbal discrimination learning could be attributed to relative frequency judgment performance in the case of the two control conditions, and to strategy identification performance in the case of the two strategy conditions.

Alternatively, the less than perfect relationships observed here may be due in part to the less than perfect reliabilities of the constituent tasks. Indeed, when these unreliabilities are taken into account (based on internal consistency estimates), the four significant correlations in Table 1 all exceed .75, with three of the four exceeding .90. On the other hand, all the nonsignificant correlations in Table 1 remain low (all less than .25) when corrected for unreliability.[2]

To summarize these results, the verbal discrimination task seems to involve almost exclusively either frequency discrimination ability or strategy discrimination ability, depending on whether it is administered in the absence or in the presence of rehearsal strategy instructions. As will be pointed out in the following discussion, such results lend support to the supplant explanation offered in the introduction.

---

[2] In this regard, the comparatively smaller significant correlations in Table 1 between relative frequency judgment performance and verbal discrimination learning than between strategy identification performance and verbal discrimination learning may be due to the lower internal consistency of the relative frequency judgment task as compared to the other two tasks.

IV

DISCUSSION

In the last ten years, much research has been devoted to evaluating the postulates of the frequency theory introduced by Ekstrand et al. (1966). In general, the theory has fared well, in that most (if not all) of the predictions based upon the theory's stipulation of the rules governing the operation of frequency within verbal discrimination and other recognition paradigms have been upheld (Eckert & Kanak, 1974; Wallace, 1972). Our own research has been concerned not so much with testing the basic tenets of the theory as with attempting to see how far the theory could be extended to account for discrimination learning phenomena in two general areas: those attributable to variations in stimulus materials and those attributable to variations in rehearsal strategies.

With respect to the stimulus materials variations which we have reviewed and investigated so far, there is no question that a frequency theory perspective can be maintained. In virtually every case where we have found a materials variation to influence discrimination learning, independently corroborated differences in apparent frequencies associated with the materials have been demonstrated. For example, pictures are learned better than words in the discrimination paradigm (Rowe, 1972; Wilder & Levin, 1973); at the same time, the two types of materials differ in apparent frequency (Ghatala & Levin, 1974; Ghatala, Levin, & Wilder, 1973), with a link between the two sets of results having been provided empirically (Levin, Ghatala, & Wilder, 1974). Similarly, the influence on discrimination learning of other stimulus materials variables such as concreteness (Galbraith & Underwood, 1973), rated imagery (Wallace, Murphy, & Sawyer, 1973), and normative frequency (Ghatala & Levin, 1974; Ghatala, Levin, & Makoid, 1975) have been accounted for in terms of frequency differences. In fact, by expanding the Weber's law notion in the initial formulation of the theory, we have also been able to provide a plausible explanation of why certain stimulus materials variations influence apparent frequency discriminations (see Ghatala & Levin, 1974; Ghatala, Levin, & Wilder, in press).

Given our success in extending frequency theory to account for discrimination learning phenomena as a function of stimulus materials variations, we were initially optimistic about the theory's also being able to handle the effects produced by variations in rehearsal strategies. Yet to date our published (Ghatala, Levin, & Wilder, 1973) and unpublished studies have not satisfactorily accounted for strategy effects in terms of the frequency attribute. However, the results of the present experiment now make it clear why a simple frequency explanation was inadequate. By adopting Underwood's (1975) individual differences approach, we have discovered that when a rehearsal strategy (of the kind employed here, at least) is applied to a verbal discrimination list, the task seems no longer to involve frequency discriminations (as it does when a strategy is not applied). Rather, our results clearly indicate that instructing subjects to employ rehearsal strategies leads them to encode alternative information concerning their activity during study, which they appear to utilize instead of frequency when making later discriminations.

On the other hand, it is possible to stretch the frequency theory position and assume that the activity attribute is based primarily on a frequency decision. That is, discriminating one's rehearsal activity involves an apparent frequency judgment associated with each item, in the same manner as in a simple recognition task. However, if frequency discrimination is the basis for performance in the strategy identification task, then this must be a different kind of discrimination than required in the relative frequency judgment task since performance in the two tasks is uncorrelated. Thus, to interpret the activity attribute in terms of frequency would require a reformulation of the present unidimensional conception of the frequency attribute which certainly detracts from its appeal to parsimony.

It is interesting to note that the correlational patterns are identical for the imagery and pronunciation strategies (see Table 1). This outcome fits well with our previous findings that while both strategies facilitate children's verbal discrimination learning to the same degree (Levin, Ghatala, DeRose, Wilder, & Norton, 1975; Levin, Ghatala, Wilder, & Inzer, 1973), neither has any influence on subjects' frequency judgment performance (Ghatala, Levin, & Wilder, 1973).

In this regard, the findings that discrimination learning phenomena associated with the use of imagery or pronunciation strategies (1) are not easily accounted for in terms of the strategies' effects on simple frequency processes (e.g., Ghatala, Levin, & Wilder, 1973; as well as some of our unpublished work), and (2) seem to fit the supplant explanation offered here may or may not hold for other types of rehearsal strategies. Where, for example, do the present strategies fall along a Craik and Lockhart (1972) depth-of-processing continuum? It seems possible to identify other rehearsal strategies which are known to influence discrimination and recognition performance (e.g., Levin, Ghatala, DeRose, Wilder, & Norton, 1975; Zechmeister & Gude, 1974) and which ostensibly reach different (either greater or lesser) levels of semantic processing than the present strategies. The question then is whether the effects of these alternative strategies are separate from frequency processes (see Rowe, 1974, for some preliminary data). In the case of strategies for which the answer to this question is yes, would subjects' ability to discriminate between usages and non-usages of the strategy (what we have called an activity attribute) supplant frequency as the predominant cue in a discrimination task (as found here for the imagery and pronunciation strategies)? In the case of strategies for which the answer to the first question is no, would frequency be used in addition to (or instead of) this activity attribute as a predominant discriminative cue? Research seeking the answers to these questions is currently underway.

It is our belief, based on the results of this experiment and those of others in similar contexts (e.g., Zechmeister & Gude, 1974), that frequency theory is not sufficient to account for rehearsal strategy effects in discrimination learning. Rather, an attribute or attributes other than frequency (e.g., activity) may be engaged when strategies are introduced into the task. This conclusion, however, does not invalidate the theory that still affords the most useful account of recognition memory presently

GPO 810-744-4

available. This experiment merely serves to help define the boundaries within which the theory is functionally operative. It is a credit to the theory that such boundary conditions can in fact be established through empirical research.

Finally, Underwood (1975) has documented the importance of individual differences as a crucible in nomothetic theory construction. It is his belief that this ingredient provides a crucial test of theories as they are being born. We concur in this belief and, on the basis of the present results, can readily appreciate the need for repeated confrontations with the crucible of individual differences in order for a fledgling theory to continue to grow and mature.

REFERENCES

Craik, F. I. M., & Lockhart, R. S. Levels of processing: A framework for memory research. Journal of Verbal Learning and Verbal Behavior, 1972, 11, 671-684.

Eckert, E., & Kanak, N. J. Verbal discrimination learning: A review of the acquisition, transfer, and retention literature through 1972. Psychological Bulletin, 1974, 81, 582-607.

Ekstrand, B. R., Wallace, W. P., & Underwood, B. J. A frequency theory of verbal discrimination learning. Psychological Review, 1966, 73, 566-578.

Galbraith, R. C., & Underwood, B. J. Perceived frequency of concrete and abstract words. Memory and Cognition, 1973, 1, 55-60.

Ghatala, E. S., & Levin, J. R. Discrimination learning as a function of differences in materials: A proposed explanation. Memory and Cognition, 1974, 2, 395-400.

Ghatala, E. S., Levin, J. R., & Makoid, L. A. A clarification of frequency effects in children's discrimination learning. Memory and Cognition, 1975, 3, 1-6.

Ghatala, E. S., Levin, J. R., & Wilder, L. Apparent frequency of words and pictures as a function of pronunciation and imagery. Journal of Verbal Learning and Verbal Behavior, 1973, 12, 85-90.

Ghatala, E. S., Levin, J. R., & Wilder, L. Pronunciation and the frequency-meaningfulness effect in children's frequency discrimination. Journal of Experimental Psychology: Human Learning and Memory, in press.

Levin, J. R., Ghatala, E. S., DeRose, T. M., Wilder, L., & Norton, R. W. A further comparison of imagery and vocalization strategies in children's discrimination learning. Journal of Educational Psychology, 1975, 67, 141-145.

Levin, J. R., Ghatala, E. S., & Wilder, L. Picture-word differences in discrimination learning: I. Apparent frequency manipulations. Journal of Experimental Psychology, 1974, 102, 691-695.

Levin, J. R., Ghatala, E. S., Wilder, L., & Inzer, E. Imagery and vocalization strategies in children's verbal discrimination learning. Journal of Educational Psychology, 1973, 64, 360-365.

Paivio, A. Imagery and verbal processes. New York: Holt, Rinehart & Winston, 1971.

Rowe, E. J. Discrimination learning of pictures and words: A replication of picture superiority. Journal of Experimental Child Psychology, 1972, 14, 303-312.

Rowe, E. J. Depth of processing in a frequency judgment task. Journal of Verbal Learning and Verbal Behavior, 1974, 13, 638-643.

Rowe, E. J., & Paivio, A. Imagery and repetition instructions in verbal discrimination and incidental paired-associate learning. Journal of Verbal Learning and Verbal Behavior, 1971, 10, 668-672.

Thorndike, E. L., & Lorge, I. The teacher's word book of 30,000 words. New York: Bureau of Publications, Teachers College, Columbia University, 1944.

Underwood, B. J. Attributes of memory. Psychological Review, 1969, 76, 559-573.

Underwood, B. J., Individual differences as a crucible in theory construction. American Psychologist, 1975, 30, 128-134.

Underwood, B. J., & Freund, J. S. Relative frequency judgments and verbal discrimination learning. Journal of Experimental Psychology, 1970, 83, 279-285.

Wallace, W. P. Verbal discrimination. In C. P. Duncan & L. B. Sechrest (Eds.), Human memory: Festschrift for Benton J. Underwood. New York: Appleton-Century-Crofts, 1972.

Wallace, W. P., Murphy, M. D., & Sawyer, T. J. Imagery and frequency in verbal discrimination learning. Journal of Experimental Psychology, 1973, 101, 201-219.

Wilder, L., & Levin, J. R. A developmental study of pronouncing responses in the discrimination learning of words and pictures. Journal of Experimental Child Psychology, 1973, 15, 278-286.

Zechmeister, E. B., & Gude, C. Instruction effects in recognition memory. Bulletin of the Psychonomic Society, 1974, 3, 13-15.

GPO 810-244-2